

FY17 GRC: Interference Tolerant Functional Near Infrared Spectrometer (fNIRS) for Cognitive State Monitoring

Completed Technology Project (2016 - 2017)



Project Introduction

Measuring hemoglobin concentration changes in the brain with Functional Near Infrared Spectroscopy (fNIRS) is a promising technique for monitoring cognitive state and optimizing human performance during both aviation and space operations. Currently available fNIRS systems are large, rack mounted devices designed for laboratory research which are susceptible to the type of radio frequency (RF) interference commonly found near airports. Cognitive research is therefore limited to a RF interference-free lab environment, impossible in any aircraft or hanger. We circumvent this problem developing a highly reliable system for crew cognitive state monitoring tolerant of RF interference which reduces hardware complexity, weight and volume. Many crew-related errors in aviation and astronautics are caused by hazardous cognitive states including overstress, disengagement, high fatigue and ineffective crew coordination. Safety can be improved by monitoring and predicting these cognitive states in a non-intrusive manner and designing mitigation strategies. We propose to develop an advanced optical instrument using the Frequency Domain (FD) method of Near Infrared Spectroscopy (NIRS), designed with state of the art opto-electronics, prototyped and integrated into new headgear designs suitable for use in commercial/military aircraft or the space environment. The goal is to enable real-time monitoring of crew cognitive state to prevent performance decrements during safety critical tasks.

Anticipated Benefits

The compact fNIRS system proposed will enable flight simulator and other field testing. Currently no commercial product exists to measure cognitive state in the field, work in this area has been experimental using rack mounted equipment in a lab environment. Successful development of a compact fNIRS cognitive state monitor would enable an innovative early warning system during long duration missions, with both space and aeronautics applications. Spaceflight applications include detecting and preventing vigilance decrements due to the effects of microgravity: motion sickness, lack of sleep, loss of sensorimotor control, increased stress or mood changes. Commercially this technology is applicable to any human in the loop system requiring improved attentional performance. Commercial pilots deal with many stressors that can compromise cognitive ability: fatigue, uncomfortable levels of noise, heat, vibration, and mental workload. Use of CSM may be able to avoid mistakes by pilots and other safety critical personnel such as air traffic controllers.



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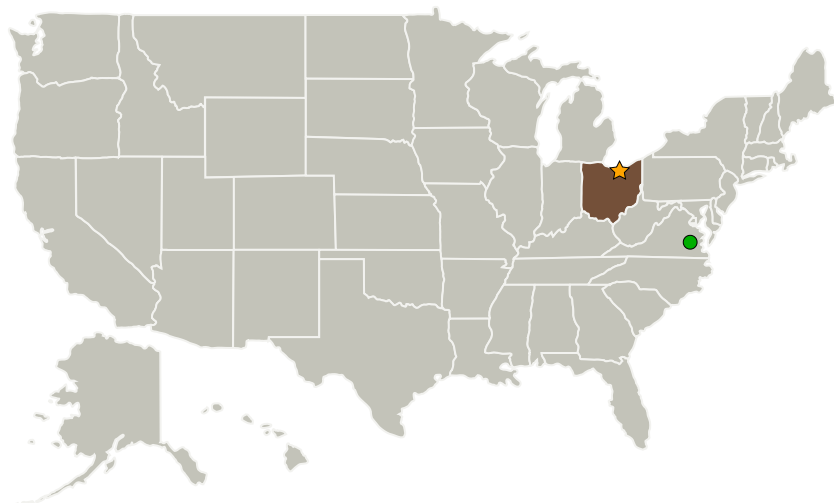
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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Glenn Research Center (GRC)	Lead Organization	NASA Center	Cleveland, Ohio
● Langley Research Center (LaRC)	Supporting Organization	NASA Center	Hampton, Virginia
Naval Medical Research Unit Dayton	Supporting Organization	US Government	Dayton, Ohio

Primary U.S. Work Locations

Ohio

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Glenn Research Center (GRC)

Responsible Program:

Center Innovation Fund: GRC CIF

Project Management

Program Director:

Michael R Lapointe

Program Managers:Kurt R Sacksteder
Gary A Horsham**Project Manager:**

Gary A Horsham

Principal Investigator:

Joanne C Walton

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Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



Technology Areas

Primary:

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
 - └ TX05.5 Revolutionary Communications Technologies
 - └ TX05.5.1 Cognitive Networking

Target Destination

Earth